Modeling Diabetes and Related Medical Care of the Future Elderly in Mexico

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Technical Appendix

Structure of the microsimulation model

The structure of the FEM-Mexico microsimulation and the differences with the HRS-FEM are presented in the Appendix Figure 1. Our simulation starts in 2012 with 20.7 Million individuals age 50+ (17.7% of the population in 2012; (CONAPO, 2012)). The simulation model estimates the risk of developing diabetes, other five chronic diseases and the survival status for each individual. Due to the structure of the model, every two years the microsimulation model updates the health status and mortality risk for each individual. To replenish the youngest cohorts, a new cohort of 50 and 51 year-old individuals are added at the beginning of each simulated cycle.

This technical appendix describes only the adaptations made to the FEM in order to work with the Mexican Health and Aging Study (MHAS), in depth details of the FEM are published everywhere (add reference).

The model's main variables are age, gender, smoke, BMI and six chronic conditions (hypertension, diabetes, heart disease, lung disease, stroke and cancer). We also create an indicator variable mortality. The baseline cohort is defined at the initial period (2001). This time period represents the first two years of the simulations (i.e., 2012 and 2013). The variables age, gender, smoke, BMI and chronic conditions are sampled from MHAS with replacement. These samples are repeated until the number of individuals in each age and sex category are equal to the Mexican population distribution in 2012.

After establishing the baseline cohort, the microsimulation iterates to the next time period by projecting the values of each variable for the next two years (i.e., 2014 and 2015). Since the 50 and 51 years individuals age to 52 and 53 years-old, respectively, at time 2, new 50 and 51 year-old individuals are added to the simulation to replenish the youngest age group. The characteristics of these new individuals are sampled with replacement from the 50-51 year-old individuals in MHAS 2012, weighted by the age- and gender-specific projected population of 50 year-olds based on the official Mexican projections (CONAPO) and imposing the trends for some of the main variables.

MHAS provides self-reported chronic conditions for each individual in 2001, 2003 and 2012. We use logistic regressions to estimate the probability of transitioning to one of the six mutually exclusive health states in 2003 based on not having that chronic condition in 2001, controlling for demographic and comorbid conditions in 2001. Then we projected transitions of self-reported diabetes, hypertension, heart attack, cancer, stroke and lung disease. The independent variables

include health status measures and basic demographic characteristics such as age, gender, smoking status or weight category, as measured at baseline in 2001. The coefficient estimates of these transitions models predict health status two years into the future (2003). All chronic conditions are treated as absorbing states.

Specific situations for FEM-Mexico

    a.   Inter-wave gap period

The first difference between the structure of the FEM-Mexico and the FEM was that in the latter, the main source of information, the Health and Retirement Study (HRS), is collected every two years and the microsimulation uses this gap time to estimate health status of the individuals. In MHAS there is three available waves, 2001, 2003 and 2012 with different inter-wave periods. We had to choose our baseline population based on the advantages that the microsimulation model presents and we decided to use the 2012 data as a baseline and the 2001-2003 information to estimate the health transitions and to run our microsimulation.

    b.   Cross-validation: Cohort analysis (MHAS 2003-2011/2013)

The next step was to corroborate that adapting the MHAS information to the FEM could lead to acceptable forecast of diabetes, to do so we run a cohort analysis using wave 2 (2003) as the start point of the simulation, then we compare the results obtained from the FEM-Mexico with the real data from MHAS wave 3 (2012). Results show that FEM-Mexico predicts effectively the prevalence of diabetes (see figure 2).

    c.   Demographic adjustments to run the simulation

1) Since age and sex distribution in the MHAS differs from the CONAPO projections we reweight the population by age and sex to have a common start point for the projections (see Figure 3).

2) Using the CONAPO projections (2010-2050) we made some adjustments on mortality probabilities and due to evident differences by age group we adjust for two groups: 50 to 64 years and 65 years and older, all calculations relative to 2012 level (see table 1)

3) Migration adjustments [by year (2013-2050) single age and sex], all calculations relative to 2012 level.

    d.   Incoming cohorts (new 50-51 years old)

We assume that the new 50-51 years old individuals will be different in several characteristics. For example, with respect to the actual cohorts, they will be more educated, with lower tobacco and alcohol consumption and with higher BMI. Using information from the Mexican National Health
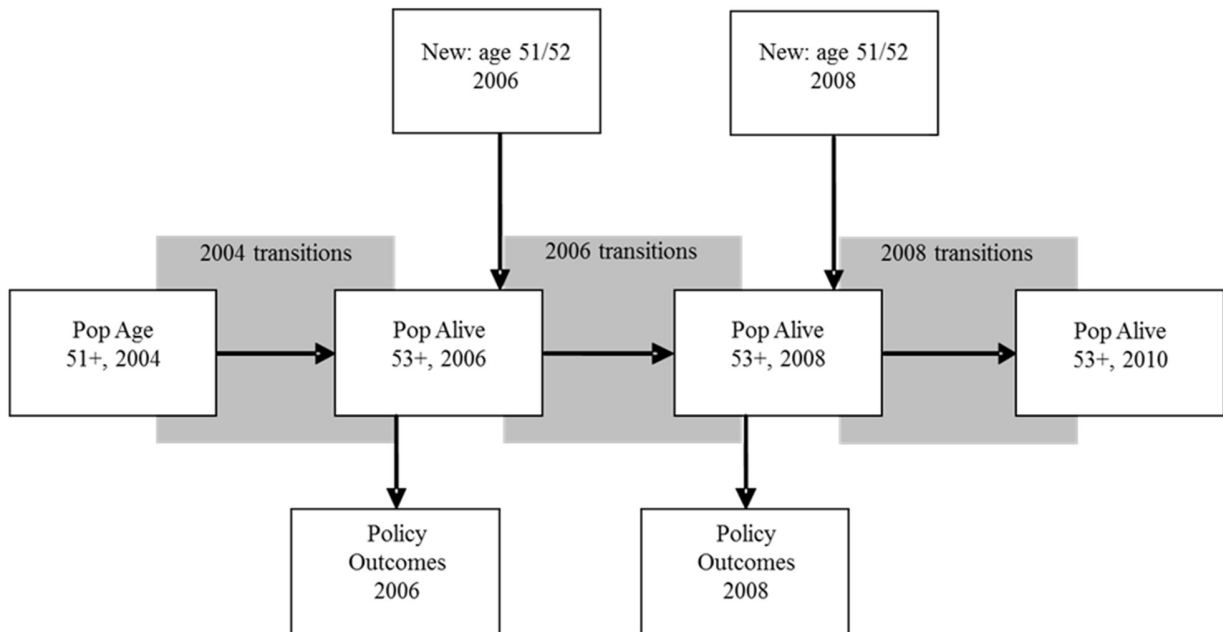
Surveys (2000, 2006 and 2012) we predicted trends for these variables and applied them to the incoming cohorts (50-51 years old).

      e. Missing data.

We used records in which the information for all the variables is complete.
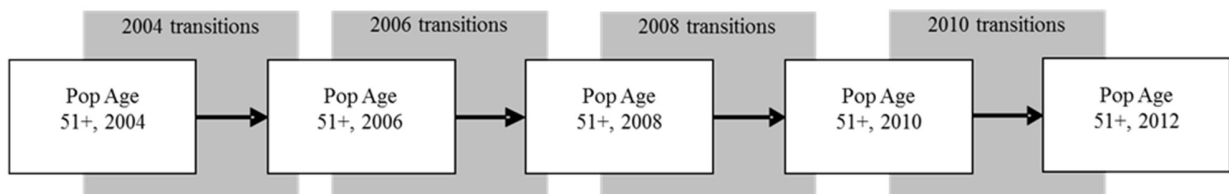
Figure 1.

Architecture of the FEM

HRS-FEM and FEM-Mexico differences

HRS

MHAS
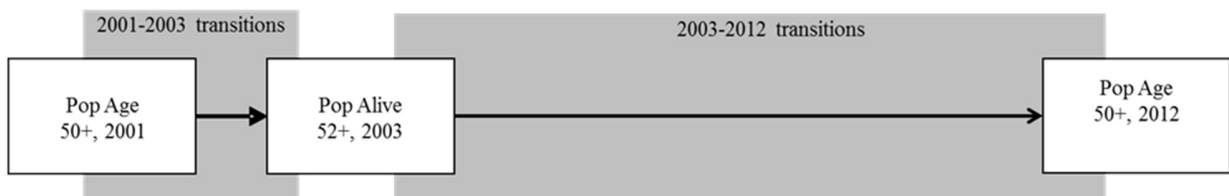
Figure 2.

Comparison between microsimulation and observed MHAS 2012

Figure 1. Prevalence of Diabetes among older adults (55+) in Mexico
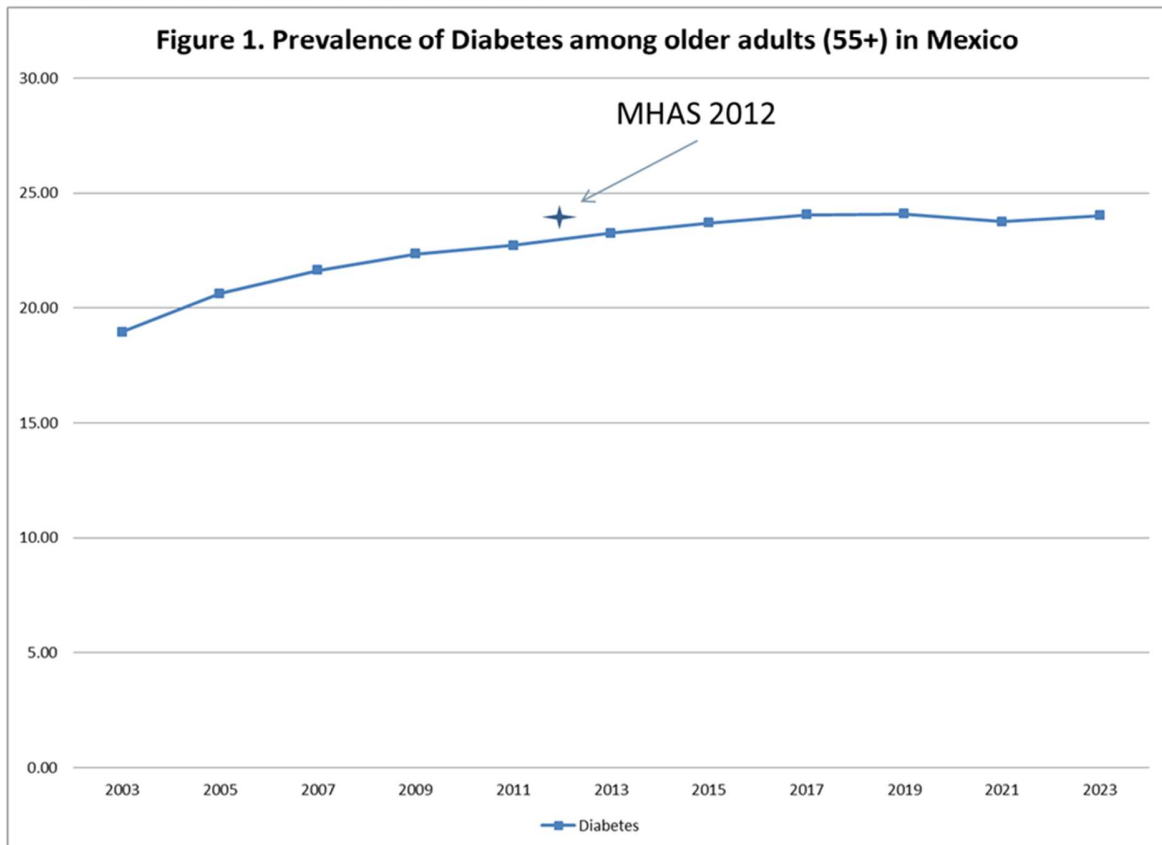
Figure 3. Population differences between MHAS and CONAPO, 2012

Source: Own calculation using information from the Mexican Health and Aging Study (MHAS 2012) and the National Population Council (CONAPO) projections (2010-2050)
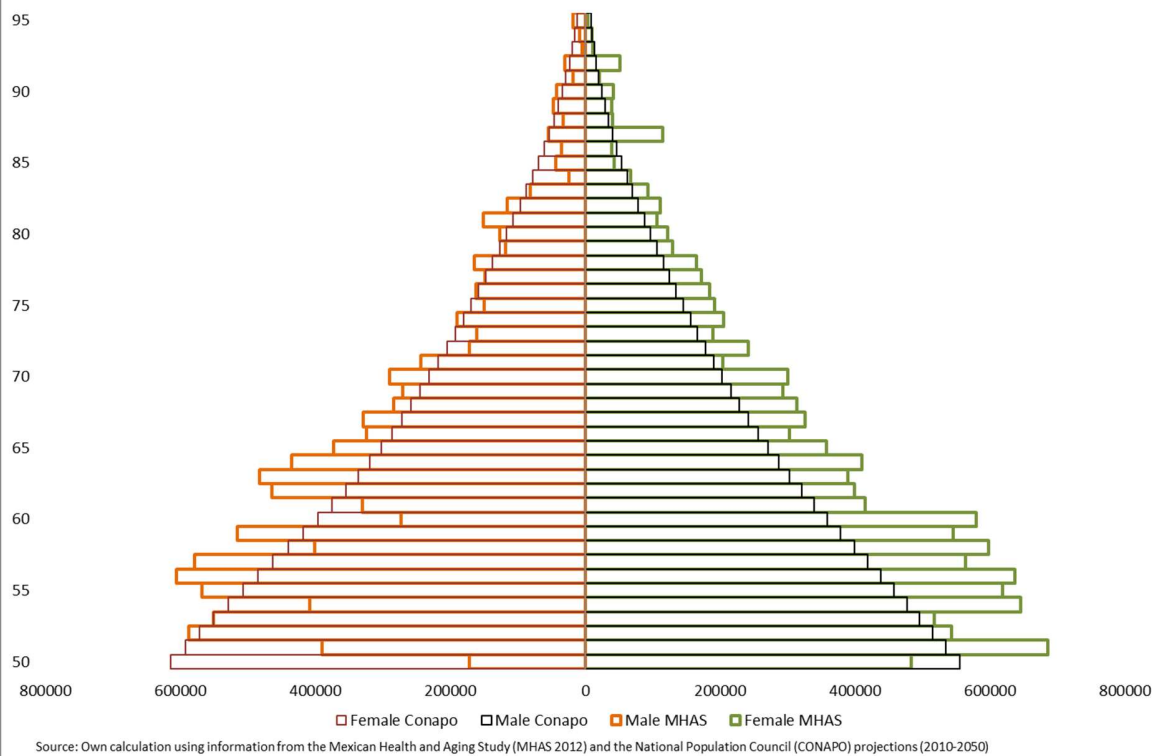
Table 1. Trends for mortality, diabetes, Body Mass Index and Smoking, 2012-2050

Year	Mortality adjustments[1]		Diabetes[2]	Body Mass Index[2]				Smoking[2]	
	50-64	65+		Overweight	Obese 1	Obese 2	Obese 3	Current	Former
2012	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2013	0.9920	0.9983	1.0176	1.0007	1.0119	1.0196	1.0458	1.0309	0.9856
2014	0.9838	0.9962	1.0354	1.0014	1.0239	1.0396	1.0935	1.0624	0.9714
2015	0.9756	0.9934	1.0534	1.0020	1.0359	1.0599	1.1433	1.0947	0.9573
2016	0.9671	0.9901	1.0718	1.0027	1.0480	1.0806	1.1952	1.1277	0.9434
2017	0.9585	0.9861	1.0904	1.0034	1.0602	1.1015	1.2492	1.1614	0.9296
2018	0.9498	0.9817	1.1092	1.0041	1.0725	1.1229	1.3056	1.1959	0.9160
2019	0.9407	0.9769	1.1283	1.0048	1.0848	1.1445	1.3642	1.2310	0.9026
2020	0.9317	0.9718	1.1477	1.0055	1.0971	1.1665	1.4253	1.2669	0.8892
2021	0.9227	0.9666	1.1674	1.0061	1.1096	1.1889	1.4888	1.3035	0.8761
2022	0.9138	0.9614	1.1873	1.0068	1.1220	1.2116	1.5549	1.3408	0.8630
2023	0.9051	0.9563	1.2075	1.0075	1.1346	1.2347	1.6237	1.3788	0.8502
2024	0.8965	0.9515	1.2279	1.0082	1.1472	1.2581	1.6952	1.4175	0.8374
2025	0.8882	0.9470	1.2487	1.0089	1.1598	1.2819	1.7695	1.4569	0.8249
2026	0.8802	0.9428	1.2697	1.0096	1.1725	1.3061	1.8467	1.4969	0.8124
2027	0.8722	0.9388	1.2909	1.0103	1.1852	1.3306	1.9268	1.5377	0.8002
2028	0.8641	0.9351	1.3125	1.0109	1.1980	1.3555	2.0100	1.5791	0.7880
2029	0.8561	0.9316	1.3343	1.0116	1.2109	1.3807	2.0964	1.6212	0.7760
2030	0.8480	0.9282	1.3564	1.0123	1.2238	1.4064	2.1859	1.6640	0.7642
2031	0.8400	0.9251	1.3788	1.0130	1.2367	1.4324	2.2787	1.7074	0.7525
2032	0.8319	0.9221	1.4014	1.0137	1.2497	1.4588	2.3749	1.7514	0.7409
2033	0.8236	0.9195	1.4244	1.0144	1.2627	1.4855	2.4744	1.7960	0.7295
2034	0.8149	0.9172	1.4476	1.0150	1.2757	1.5126	2.5775	1.8412	0.7182
2035	0.8058	0.9153	1.4711	1.0157	1.2888	1.5402	2.6841	1.8870	0.7071
2036	0.7962	0.9138	1.4949	1.0164	1.3019	1.5681	2.7943	1.9334	0.6961
2037	0.7866	0.9128	1.5189	1.0171	1.3150	1.5963	2.9082	1.9803	0.6852
2038	0.7766	0.9124	1.5432	1.0178	1.3282	1.6250	3.0259	2.0277	0.6745
2039	0.7660	0.9125	1.5678	1.0185	1.3414	1.6540	3.1472	2.0757	0.6639
2040	0.7551	0.9133	1.5927	1.0192	1.3546	1.6835	3.2724	2.1241	0.6535
2041	0.7439	0.9146	1.6179	1.0198	1.3678	1.7133	3.4015	2.1730	0.6431
2042	0.7327	0.9163	1.6433	1.0205	1.3811	1.7434	3.5344	2.2223	0.6330
2043	0.7216	0.9183	1.6690	1.0212	1.3944	1.7740	3.6712	2.2721	0.6229
2044	0.7106	0.9206	1.6950	1.0219	1.4077	1.8050	3.8119	2.3222	0.6130
2045	0.6997	0.9234	1.7213	1.0226	1.4210	1.8363	3.9565	2.3727	0.6032
2046	0.6892	0.9267	1.7478	1.0233	1.4343	1.8680	4.1050	2.4235	0.5936
2047	0.6791	0.9303	1.7746	1.0239	1.4477	1.9001	4.2574	2.4747	0.5841
2048	0.6694	0.9340	1.8017	1.0246	1.4610	1.9326	4.4136	2.5261	0.5747
2049	0.6600	0.9376	1.8290	1.0253	1.4744	1.9655	4.5737	2.5778	0.5654
2050	0.6517	0.9419	1.8566	1.0260	1.4877	1.9987	4.7376	2.6297	0.5563

[1] Trends calculated using CONAPO Projections (2010-2050)

[2] Trends calculated using Mexican National Health Surveys (2000, 2006 and 2012)